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(54) Improved diffusion coating process and products

Verbessertes Verfahren zur Diffusionsbeschichtung und Produkte

Procédé amélioré pour le revêtement par diffusion et produits

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(56) References cited:
DE-A- 1 955 203 FR-A- 2 301 609

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DescriptionBackground of the Invention5 Field of the Invention:

The present invention relates to the coating of high temperature superalloys, such as high nickel-and high cobalt-superalloys to provide them with a protective outer layer which has improved resistance to oxidation and corrosion when subjected to such atmospheres at high temperatures. An important use of such superalloys is for turbine blades in jet aircraft or power generation engines which perform at high temperatures and in corrosive and oxidizing atmospheres.

Discussion of the Prior Art:

15 It is known to form protective coatings on the surface of metal superalloy components, such as turbine blades, using metals to form layers which are more resistant to corrosion and/or oxidation at high temperatures than is the base superalloy.

According to one such procedure, disclosed in U.S. Patent 3,677,789 by Bungardt et al., the base superalloy is first coated with a thin layer of noble metal, such as platinum, and is then subjected to a high temperature aluminum diffusion treatment for several hours to form a protective layer diffused into and integrated with the base superalloy. The formed protective surface layer comprises platinum aluminide which has the disadvantages of being brittle, subject to craze cracking and has low impact strength.

Diffusion coating compositions and procedures for diffusing both aluminum and chromium into superalloy base metal components in a single step are known from U.S. Patent 4,293,338 by Rose et al. Thus, the prepared superalloy base component is packed into a conventional diffusion-coating container together with a powdered cementation pack coating composition containing intermetallic Co_2Al_9 powder and chromium metal powder, heated to about 1052-1080°C (1925°-1975°F) for about one-two hours in an inert gas atmosphere, removed and post-treated in a hydrogen atmosphere for about one hour at about 1066°C (1950°F). A codeposited diffusion layer of aluminum and chromium is thereby provided at the superalloy metal surface, but in the absence of any platinum group metal.

30 According to another known procedure, disclosed in U.S. Patent 4,526,814 by Shankar et al., protective diffusion layers of a platinum group metal, chromium and aluminum are formed at the surface of superalloy base components in a multi-step process in which the superalloy base component is first coated with the platinum group metal, post-platinized at about 1038°C (1900°F) for three hours to diffuse the platinum metal into the superalloy, then high temperature-chromized at 1066°C (1950°F) for eight hours to form a diffusion layer of the platinum group metal and chromium into the superalloy, and then high temperature-aluminized at about 760°C (1400°F) for five hours, to form a diffusion layer of the platinum group metal, chromium and aluminum into the superalloy base surface. Next a post-coating diffusion treatment at 1080°C (1975°F) for 2 to 4 hours is done. Such procedure is tedious and expensive because of the several steps including the post-platinizing heating step and the pre-aluminizing heating step. Also, in cases where low amounts of chromium are diffused into the protective layer the layer is limited in effectiveness of protection to high temperature oxidation and high temperature hot corrosion application [1093°C-927°C (2000°F-1700°F)].

Summary of the Invention

45 The present invention relates to a simplified process for the diffusion coating of metallic superalloy bodies or components with a platinum group metal to form an outer zone comprising an aluminide of a platinum group metal, or such an aluminide in a beta NiAl matrix, depending upon the substrate alloy or thermal cycle used, and then diffusion-coating the platinized substrate with an aluminum and chromium powder composition to codeposit and diffuse into the PtAl_2 a predetermined amount of beta chromium to render the normally-brittle PtAl_2 layer ductile. The formed ductile protective layer or zone substantially improves the high temperature stability of the superalloy bodies or components against corrosion, erosion and oxidation.

55 The novel process of the present invention as defined in claim 1 comprises the steps of (a) depositing a uniform thin layer of platinum-group metal, preferably platinum, onto the surface of a high temperature-resistant superalloy body, such as a high-nickel or high-cobalt metal superalloy gas turbine blade, (b) applying a post-platinizing thermal cycle to diffuse the platinum-group metal into the superalloy surface and improve the adherence or bond between the platinum-group metal layer and the substrate prior to further processing, (c) diffusion-coating said platinized surface at elevated temperatures with a composition containing more than 90% by weight of an inert particulate filler and less than 10% by weight of a powder mixture containing sources of aluminum and chromium, and (d) subjecting the diffusion-

coated superalloy body to a thermal treatment in a hydrogen gas atmosphere to produce a ductile protective microstructure layer comprising a matrix of platinum-group metal aluminide having solutioned therein an amount from 3% to 6% by weight of beta chromium, or a beta matrix of NiAl_3 containing a said platinum-group metal aluminide having solutioned herein an amount from 3% to 6% by weight of beta chromium.

The present diffusion process is not only simple, rapid and efficient but also self-regulating in that the platinum aluminide beta matrix is formed in the presence of predetermined critical amounts of chromium under diffusion conditions. This results in a solutioning of the beta chromium within the platinum aluminide matrix whereby ductilization of the formed protective layer is achieved after post-coating heat treatment to obtain the proper microstructure.

The present process is applicable to conventional high temperature superalloys which are commercially-available particularly for use in the jet turbine engine and power generation engine field. An assortment of such high nickel alloys are available from International Nickel Company under the designations IN-713 (12.5% chromium and 3% aluminum), IN-738 (16% chromium and 3% aluminum) and IN-792 (12.5% chromium and 3% aluminum). Other similar nickel superalloys are available under the designations Rene 80 (13.5% chromium and 3% aluminum), Mar-M 002 (9% chromium and 5.5% aluminum), and SRR-99 (8.5% chromium and 5% aluminum).

Preferred embodiments of the process are defined in dependent claims 2-11. Moreover the resulting metal superalloy body is defined in claims 12-15.

Detailed Description of the Invention

The superalloy bodies or components which are treated according to the present invention are well known metal superalloys intended for high temperature performance, such as jet turbine components, particularly blades. Such alloys have a high content of nickel and/or of cobalt.

The first step of the present process involves depositing a uniform thin layer of a platinum-group metal, such as platinum, palladium or rhodium, onto the superalloy surfaces to be protected, using any desired coating procedure such as electroplating, chemical vapor deposition, or the like. Preferably, the superalloy surfaces are prepared to improve their receptivity for the coating and to exclude contaminants, such as by conventional chemical cleaning and/or degreasing procedures. The thickness of the platinum-group metal deposit preferably is between about 5-10 μm .

Next, the platinum-group metal-coated superalloy is subjected to a post-platinizing thermal cycle, such as by heating in vacuo to between about 1024°C (1875°F) and 1052°C (1925°F), preferably about 1058°C \pm 8°C (1900°F \pm 15°F), for about 1 hour, to diffuse or integrate the platinum-group metal into the coated surface of the superalloy body and also to check the adherence of the platinum coating to the superalloy body. The choice of a temperature of about 1058°C (1900°F) is dictated by the need to dilute the platinum-group metal concentration into the substrate so that the lattice parameter of the formed PtAl_2 will accommodate beta chromium diffusion, and also by the need to check adherence of the platinum-group metal layer.

The platinum-group metalized superalloy body is then subjected to conventional diffusion coating with an aluminum/chromium powder codeposition in a single step, using a diffusion powder-pack composition and procedure as disclosed in U.S. Patent 4,293,338.

Finally, the Al/Cr diffusion-coated, metallized superalloy body is subjected to a post-coating heat treatment in hydrogen at about 1052°C (1925°F) to 1121°C (2050°F) for about one-to-two hours to produce the desired microstructure comprising a ductile platinum group metal aluminide matrix having solutioned therein from 3% to 6% by weight of beta chromium. The powder-pack compositions useful according to the present invention emit both aluminum and chromium at elevated temperatures below about 1093°C (2000°F) and are resistant to being immobilized at about 1093°C (2000°F) whereby they remain flowable after being heated for 2 hours at the diffusion temperatures, i.e., 1052°C (1925°F) to about 1080°C (1975°F). The composition contains over 90% by weight of a particulate inert filler, such as calcined aluminum oxide, a small amount of a halide carrier material or activator such as sodium fluoride or aluminum fluoride, and powdered sources of aluminum and chromium, such as Co_2Al_3 and chromium metal powder. The proportions of the metal source powders can be varied depending upon the composition of the base alloy and the properties desired. Higher aluminum contents produce greater oxidation resistance whereas higher chromium contents produce greater hot corrosion resistance. Generally, the aluminum source powder is present in an amount between about 1 to 15% by weight and the chromium source powder is present in an amount between about 2 and 6% by weight. Preferred powder compositions contain 3% by weight of Co_2Al_3 and from about 2% by weight (low chromium) to about 5% by weight (high chromium) of chromium powder.

The diffusion process is conducted by inserting the platinum-group metal-coated and thermally-cycled superalloy body or component into a diffusion powder box which is packed with the desired aluminum/chromium source powder composition. The powder box is heated rapidly in a hydrogen gas atmosphere to a temperature of 1020°C-1066°C (1850°F-1950°F) for one-to-two hours to generate the aluminum and chromium vapors and simultaneously diffuse them and the platinum-group metal into the superalloy surface. Thereafter, the treated superalloy body is removed from the diffusion powder, box, brushed clean and subjected to a post-coating heating step in which it is heated in a

hydrogen atmosphere for about one-to-two hours at the gamma prime solvus temperature of the substrate, generally between about 1052°C (1925°F) and 1121°C (2050°F) depending upon the particular substrate alloy, to produce the desired ductile microstructure surface of platinum-group metal aluminide containing from 3% to 6% by weight of dissolved chromium. Preferred thermal cycling in the diffusion powder box comprises heating to 1024°C ± 14°C (1875°F ± 25°F) for about one hour followed by heating to 1052°C ± 14°C (1925°F ± 25°F) for about 30 minutes.

The following examples are given as illustrative and should not be interpreted as limitative.

EXAMPLE 1

Turbine blade workpieces, cast from a high-nickel, high-chrome alloy sold under the trade designation "IN-738" by the International Nickel Company, are degreased by exposure to trichloroethane solvent vapors. The area of the turbine blades to be subjected to the diffusion coating process are abrasively cleaned with Al₂O₃ grit (which passes a 120 mesh sieve but not a 220 mesh sieve). After this blasting process, the turbine blades are then electrolytic alkaline cleaned, electrolytic muriatic acid cleaned, rinsed in deionized water and then platinum plated in a bath consisting of:

8.2 g./l. of hexachloroplatinic acid, H₂PtCl₆,
45 g./l. of triammonium phosphate, (NH₄)₃PO₄,
240 g./l. of di-sodium hydrogen phosphate, Na₂HPO₄

The temperature of the bath was 72°C, the pH was 7.5, the current density 538,2 A/m² (50 amps./sq. ft.) and the voltage 2.5 volts. The blades were plated for two hours and 15 minutes under these conditions. Different thickness of the platinum coating can be deposited by altering the treatment times accordingly.

After being platinum coated, the parts are thermally-cycled at 1038°C ± 8°C (1900°F ± 15°F) for one hour to diffuse or integrate the platinum into the coated surface of the superalloy and to check the adherence of the said platinum coating with the substrate superalloy.

Next, the platinized turbine blades are inserted into a coating container, which has been prepared according to procedures known in the art, and packed in a coating powder formulation comprising:

Constituents	% by weight
Calcined aluminum oxide (pass 100 mesh)	94.5%
Co ₂ Al ₉ (pass 325 mesh)	3.0%
Chromium powder (pass 325 mesh)	2.0%
Ammonium Fluoride	0.5%

This is designated as the RB-505A blend and has a high aluminum content for applications requiring high oxidation resistance.

Workpieces are placed in the coating container in spaced relation so that there is about a 19,1 mm (0.75") gap between adjacent pieces.

The powder box is loaded into a retort which is provided with means to circulate gas therethrough, means to insert thermocouples therein for the remote reading of temperature therein and a sand seal to prevent the ingress of air thereto. After the retort is closed, it is purged with hydrogen gas at a rate of about 7 volume changes per hour and then placed into a gas-fired pit furnace. Hydrogen gas is constantly fed into the retort at a rate of about 5 volume changes per hour as the temperature inside the retort was rapidly raised to 1024°C ± 14°C (1875°F ± 25°F), and held there for an hour, then raised to 1052°C ± 14°C (1925°F ± 25°F) and held there for 30 minutes. The retort was then withdrawn from the furnace, and the parts were unpacked from the powder pack.

The coated nickel-base turbine blades were carefully cleaned with a stiff-bristled brush and compressed air. Thereupon, the part was inspected and washed for three minutes in warm water and dried.

The parts were then loaded in a clean retort not previously used for diffusion coating and heat treated under vacuum in a hydrogen atmosphere for 1 to 2 hours at 1052°C (1925°F) to 1121°C (2050°F), depending on the microstructure desired. Purging technique and gas flow rates are similar to that described for the diffusion coating process, above.

After metallographic examination of a test piece so treated, an excellent codeposited diffusion coating of about 0.064 mm (0.0025 inches) in depth was achieved during this process.

A microhardness scan of the outer zone of the formed coating shows increased ductility compared to that of a conventional platinum-reinforced aluminide surface. Thus, while a brittle platinum aluminide coating has an average Knoop Hardness Number (KHN) of about 954, compared to a typical KHN of about 502 for the metal superalloy per se, the present platinum aluminide coatings containing solutioned chromium have a KHN of about 806 and are ductile

and non-brittle.

EXAMPLE 2

Example 1 is repeated but with a turbine nozzle guide vane of IN-713 alloy which is a low chromium content alloy intended for use in a high hot corrosion environment and which is platinum-coated and thermally-cycled as in Example 1. The following diffusion powder formulation is used:

Constituents	Parts by Weight
Co ₂ Al ₉ #325 mesh	3.0
Chromium, #325 mesh	4.0
NaF	0.5
Calcined aluminum oxide, #100 mesh	92.5

This is designated as the RB505-B blend and has a high chrome content for applications requiring high hot corrosion resistance.

The pack temperature was 1038°C (1900°F) and the treatment time was two hours in a hydrogen atmosphere. The post-treatment was at 1080°C (1975°F) for one hour in a partial pressure of argon of 1,33-2 Pa (10 to 15 microns) and resulted in an excellent codeposited diffusion coating of platinum, aluminum and chrome of 0,076 mm (0.003 inches) in depth.

EXAMPLE 3

This example relates to the protection of hollow-turbine blades of medium chromium content Rene 80 superalloy having internal cooling passages.

Example 1 was repeated except that the platinized, thermally-cycled parts have small apertures or conduits about 0,51 mm (0.020 inches) in diameter. The platinized parts are supported on a vibrating table so that orifices, conduits and interstices, as small as 0.254 mm (0.010 inch), are upwardly. Lower outlets of such orifices are taped to prevent egress of powder. Then, while the table is vibrated, the orifices, conduits and interstices are filled with a powder of the following formulation:

Constituents	Parts by Weight
Co ₂ Al ₉ #325 mesh	10.0
Chromium, #325 mesh	1.0
NH ₄ F	0.75
Calcined, aluminum oxide, #100 mesh	88.25

This is designated as the RB505-E blend for applications requiring high hot corrosion resistance of internal surfaces.

After the interstices are filled and the upper outlets taped shut, vibrating is continued for about two minutes. Then the turbine blades are carefully packed in the RB505-B blend of Example 2.

The heat treating step is carried out at about 1052°C (1925°F) for two hours in an argon atmosphere and an excellent codeposited diffusion coating was obtained simultaneously on the interior and exterior surfaces of the articles being treated.

This procedure for simultaneously applying an internal coating and external coating using two pack chemistries and a single thermal cycle is known as SIMULCOAT™.

It is to be understood that the above described embodiments of the invention are illustrative only and that modifications throughout may occur to those skilled in the art. Accordingly, this invention is not to be regarded as limited to the embodiments disclosed herein but is to be limited as defined by the appended claims.

Claims

1. Process for increasing the resistance of metal superalloys to oxidation and corrosion at high temperatures comprising the steps of:

(a) applying to the surface of a nickel superalloy body a thin layer of a platinum-group metal;

(b) heating the superalloy body to an elevated temperature to diffuse or integrate the platinum-group metal into the surface of the metal superalloy;

(c) packing the superalloy body into a diffusion coating container filled with a diffusion powder composition containing more than 90% by weight of an inert particulate filler and less than 10% by weight of a powder mixture containing sources of aluminum and chromium, said composition being in contact with the surface of said superalloy body into which said platinum-group metal has been diffused or integrated;

(d) heating said diffusion powder composition in a hydrogen gas atmosphere to an elevated temperature for a sufficient period of time to diffuse both aluminum and chromium into said surfaces; and

(e) removing said superalloy body from said diffusion coating container and heating it in a hydrogen gas atmosphere to the solvus temperature of the superalloy body

thereby forming a body having oxidation-resistant and corrosion-resistant ductile surfaces having a microstructure comprising an outer zone of a normally brittle aluminide of said platinum-group metal which is ductilized by the solutioning therein of from 3% to 6% by weight of beta chromium.

2. Process according to claim 1 in which said platinum-group metal comprises platinum.
3. Process according to claim 1 in which said superalloy body comprises a major amount by weight of nickel.
4. Process according to claim 1 in which said diffusion powder composition comprises a mixture of Co_2Al_9 powder and chromium metal powder.
5. Process according to claim 4 in which said diffusion powder composition contains from about 1% to 15% by weight of Co_2Al_9 powder and from about 2% to 6% by weight of chromium metal powder.
6. Process according to claim 1 in which step (a) comprises electroplating the surface of the nickel superalloy body with a layer of said platinum-group metal having a thickness up to about 10 μm .
7. Process according to claim 1 in which the heating in step (b) is conducted at a temperature between 1024°C-1052°C (1875°F and 1925°F).
8. Process according to claim 1 in which the heating in step (d) is conducted at a temperature between 1010°C-1066°C (1850°F and 1950°F).
9. Process according to claim 1 in which the heating in step (e) is conducted at a temperature between 1052°C-1121°C (1925°F and 2050°F).
10. Process according to claim 1 in which the aluminide is platinum aluminide which has solutioned therein from 3% to 6% by weight of the chromium.
11. Process according to claim 1 in which said ductilized platinum aluminide is present within a beta phase nickel aluminide matrix.
12. A metal superalloy body having increased resistance to oxidation and corrosion at elevated temperatures, said superalloy body having surface areas comprising an outer zone of an aluminide of a platinum-group metal ductilized by the solutioning therein of 3% to 6% by weight of beta chromium.
13. A metal superalloy body according to claim 12 in which said platinum-group metal comprises platinum.
14. A metal superalloy body according to claim 12 in which said superalloy comprises a major amount by weight of nickel.
15. A metal superalloy body according to claim 12 in which said ductilized platinum aluminide is present within a beta

phase nickel aluminide matrix.

Patentansprüche

- 5
1. Verfahren zur Erhöhung der Beständigkeit von Metallsuperlegierungen gegenüber Oxidation und Korrosion bei hohen Temperaturen, umfassend die Schritte:

10 (a) Aufbringen einer dünnen Schicht eines Platingruppenmetalls auf die Oberfläche eines Nickelsuperlegierungskörpers,

(b) Erwärmen des Superlegierungskörpers auf eine erhöhte Temperatur um das Platingruppenmetall in die Oberfläche der Metallsuperlegierung einzudiffundieren oder zu integrieren,

15 (c) Packen des Superlegierungskörpers in einen Diffusionsbeschichtungsbehälter, der mit einer Diffusionspulverzusammensetzung, enthaltend mehr als 90 Gew.-% eines inerten teilchenförmigen Füllstoffs und weniger als 10 Gew.-% eines Pulvergemisches, das Quellen für Aluminium und Chrom enthält, gefüllt ist, wobei die Zusammensetzung mit der Oberfläche des Superlegierungskörpers, in die das Platingruppenmetall eindiffundiert oder integriert wurde, in Kontakt steht,

20 (d) Erwärmen der Diffusionspulverzusammensetzung in einer Wasserstoffgasatmosphäre auf eine erhöhte Temperatur für einen ausreichenden Zeitraum um sowohl Aluminium als auch Chrom in die Oberflächen einzudiffundieren, und

25 (e) Entfernen des Superlegierungskörpers aus dem Diffusionsbeschichtungsbehälter und Erwärmen davon in einer Wasserstoffgasatmosphäre auf die Solvustemperatur des Superlegierungskörpers,

wodurch ein Körper gebildet wird mit oxidationsbeständigen und korrosionsbeständigen duktilen Oberflächen mit einer Mikrostruktur, umfassend eine äußere Zone eines normalerweise spröden Aluminids des Platingruppenmetalls, die durch das Lösen von 3 Gew.-% bis 6 Gew.-% beta Chrom darin duktilisiert wird.

- 30 2. Verfahren nach Anspruch 1, wobei das Platingruppenmetall Platin umfaßt.

3. Verfahren nach Anspruch 1, wobei der Superlegierungskörper eine große Gewichtsmenge Nickel umfaßt.

- 35 4. Verfahren nach Anspruch 1, wobei die Diffusionspulverzusammensetzung ein Gemisch von Co_2Al_9 Pulver und Chrommetall Pulver umfaßt.

- 40 5. Verfahren nach Anspruch 4, wobei die Diffusionspulverzusammensetzung von etwa 1 Gew.-% bis 15 Gew.-% Co_2Al_9 Pulver und von etwa 2 Gew.-% bis 6 Gew.-% Chrommetall Pulver enthält.

6. Verfahren nach Anspruch 1, wobei Schritt (a) das Elektroplattieren der Oberfläche des Nickelsuperlegierungskörpers mit einer Schicht des Platingruppenmetalls mit einer Schichtdicke von bis zu 10 μm umfaßt.

- 45 7. Verfahren nach Anspruch 1, wobei das Erwärmen in Schritt (b) bei einer Temperatur zwischen 1024°C - 1052°C (1875°F und 1925°F) durchgeführt wird.

8. Verfahren nach Anspruch 1, wobei das Erwärmen in Schritt (d) bei einer Temperatur zwischen 1010°C - 1066°C (1850°F und 1950°F) durchgeführt wird.

- 50 9. Verfahren nach Anspruch 1, wobei das Erwärmen in Schritt (e) bei einer Temperatur zwischen 1052°C - 1121°C (1925°F und 2050°F) durchgeführt wird.

- 55 10. Verfahren nach Anspruch 1, wobei das Aluminid Platinaluminid ist, das von 3 Gew.-% bis 6 Gew.-% des Chroms darin gelöst enthält.

11. Verfahren nach Anspruch 1, wobei das duktilisierte Platinaluminid in einer beta-Phase Nickelaluminid Matrix vorliegt.

12. Metallsuperlegierungskörper mit erhöhter Beständigkeit gegenüber Oxidation und Korrosion bei erhöhten Temperaturen, wobei der Superlegierungskörper Oberflächen aufweist, umfassend eine äußere Zone eines Aluminids eines Platingruppenmetalls, die durch das Lösen von 3 Gew.-% bis 6 Gew.-% beta Chrom darin duktilisiert ist.

13. Metallsuperlegierungskörper nach Anspruch 12, wobei das Platingruppenmetall Platin umfaßt.

14. Metallsuperlegierungskörper nach Anspruch 12, wobei die Superlegierung eine große Gewichtsmenge Nickel umfaßt.

15. Metallsuperlegierungskörper nach Anspruch 12, wobei das duktilisierte Platinaluminid in einer beta-Phase Nickelaluminid Matrix vorliegt.

Revendications

1. Procédé pour accroître la résistance de superalliages métalliques à l'oxydation et à la corrosion aux températures élevées, comprenant les étapes consistant à :

(a) appliquer sur la surface d'un corps de superalliage de nickel une mince couche d'un métal du groupe platine ;

(b) chauffer le corps de superalliage à une température élevée pour diffuser ou intégrer le métal de groupe platine dans la surface du superalliage métallique ;

(c) charger le corps de superalliage dans un conteneur de revêtement par diffusion rempli d'une composition de poudre de diffusion contenant plus de 90 % en poids d'une matière de charge particulière inerte et moins de 10 % en poids d'un mélange de poudre contenant des sources d'aluminium et de chrome, cette composition étant en contact avec la surface du corps de superalliage dans laquelle ce métal de groupe platine a été diffusé ou intégré ;

(d) chauffer la composition de poudre de diffusion dans une atmosphère de gaz hydrogène à une température élevée pendant une durée suffisante pour diffuser à la fois l'aluminium et le chrome dans ces surfaces ; et

(e) enlever le corps de superalliage de ce conteneur de revêtement par diffusion et le chauffer dans une atmosphère de gaz hydrogène à la température de solubilité du corps de superalliage

permettant ainsi de former un corps comportant des surfaces ductiles résistantes à la corrosion et résistantes à l'oxydation avec une microstructure comprenant une zone extérieure d'un aluminide normalement fragile de ce métal de groupe platine qui est ductilisée par la mise en solution dans celui-ci de 3 % à 6 % en poids de bêta chrome.

2. Procédé selon la revendication 1, dans lequel le métal de groupe platine comprend le platine.

3. Procédé selon la revendication 1, dans lequel le corps de superalliage comprend une importante quantité en poids de nickel.

4. Procédé selon la revendication 1, dans lequel la composition de poudre de diffusion comprend un mélange de poudre de Co_2Al_9 et de poudre de métal de chrome.

5. Procédé selon la revendication 4, dans lequel la composition de poudre de diffusion contient de environ 1 % à 15 % en poids de poudre de Co_2Al_9 et d'environ 2 % à 6 % en poids de poudre de métal de chrome.

6. Procédé selon la revendication 1, dans lequel l'étape (a) comprend l'électroplacage de la surface du corps de superalliage au nickel avec une couche de métal de groupe platine ayant une épaisseur jusqu'à environ 10 μm .

7. Procédé selon la revendication 1, dans lequel le chauffage dans l'étape (b) est conduit à une température entre 1024°C-1052°C (1875°F et 1925°F).

8. Procédé selon la revendication 1, dans lequel le chauffage à l'étape (d) est conduit à une température entre 1010°C-1066°C (1850°F et 1950°F).

9. Procédé selon la revendication 1, dans lequel le chauffage à l'étape (e) est conduit à une température entre 1052°C-1121°C (1925°F et 2050°F).

10. Procédé selon la revendication 1, dans lequel l'aluminide est de l'aluminide de platine qui a solubilisé dans celui-ci de 3 % à 6 % en poids du chrome.
- 5 11. Procédé selon la revendication 1, dans lequel l'aluminide de platine ductilisé est présent dans une matrice d'aluminide de nickel en phase bêta.
- 10 12. Corps de superalliage métallique ayant une résistance accrue à l'oxydation et à la corrosion à température élevée, ce corps de superalliage ayant des surfaces comprenant une zone extérieure d'un aluminide d'un métal de groupe platine ductilisé par la solubilisation dans celui-ci de 3 % à 6 % en poids de bêta chrome.
13. Corps de superalliage métallique selon la revendication 12, dans lequel le métal de groupe platine comprend le platine.
- 15 14. Corps de superalliage métallique selon la revendication 12, dans lequel le superalliage comprend une quantité importante en poids de nickel.
15. Corps de superalliage métallique selon la revendication 12, dans lequel l'aluminide de platine ductilisé est présent à l'intérieur d'une matrice d'aluminide de nickel en phase bêta.

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